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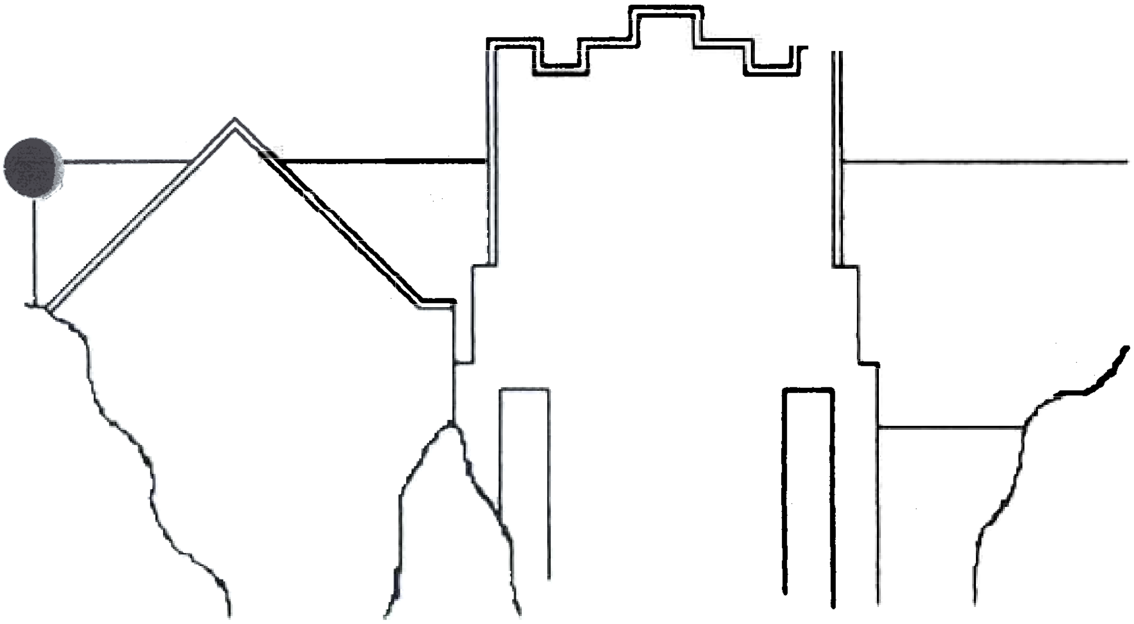

MICHIGAN STATE UNIVERSITY COMPUTER LABORATORY

EAST LANSING, MICHIGAN 48824-1042

ACRONYMS

Mid-Summer Issue
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Computer Laboratory Mainframe Service Suspended September 9-13

The Computer Laboratory is currently planning to suspend mainframe service from 8:00 a.m., Monday, September 9 through midnight Friday, September 13. During this time old equipment will be removed and the new CDC 830 and IBM 4381 mainframes will be installed.

Be aware that the currently scheduled dates may change due to unforseen circumstances. Watch for signs posted throughout the Computer Center.

Dr. Lewis Greenberg, Computer Laboratory

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ACRONYMS

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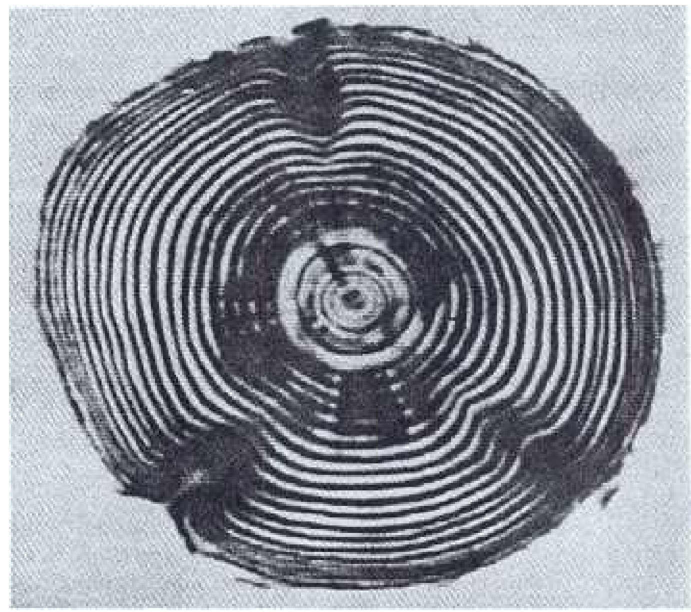
Feature Article

Computers, Lasers and Wood Manufacturing

The Applications Programming (AP) section of the Computer Laboratory is working on a program that could help revolutionize the way manufacturers of solid wood products produce their parts. The program is being written for a group of specialists in wood manufacturing. This group includes people from the Southern Forest Experimental Station, Louisiana State Univerisity, Mississippi State University and Michigan State University. The program will take into account the location and type of all defects in a given board. It will also utilize a list of parts to be cut. The program then calculates the maximum number of parts on the list that can be cut from the board, and puts out a series of coordinates identifying where cuts in the board should be made for these parts. The program is revolutionary in several ways, one of which is that the coordinates will be used to control a laser woodcutting beam. This laser beam actually cuts the parts from the board.



Computer tomograph of the cross section of a log

Although the idea for such a program is not a new one, and similar programs already exist, the program currently being developed by AP is more sophisticated and takes advantage of several recent technological advances. In fact, the entire process that manufacturers of solid wood parts use in creating their wares is being transformed by innovations in such diverse fields as tomography, image processing, computer science and laser technology. A system that utilizes this advanced technology is denoted as an Automated Lumber Processing System or ALPS, and the program being written by AP is one link in the long, highly technical chain of ALPS.

Axial Tomography

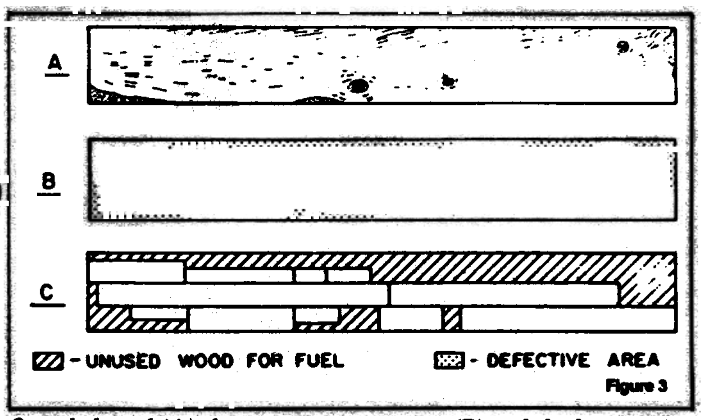
The ALPS process first begins in the sawmill, after a tree has been felled and delimbed. There the log is scanned with a specialized imaging technique known as Industrial Photon Tomography (IPT), which is similar to a CAT (Computer-Aided Tomography) scan. The IPT technique x-rays each individual axial slice of the log, detecting such defects as knots and cracks. This information is fed into a computer, and the computer then determines 1) where all the defects are in the entire log, and 2) how to rotate the log in such a way as to produce the longest and best boards when the log is sawed. After this information is determined, the computer positions the log, the saws are activated, and the log is cut into boards. This tandem process of using IPT scans and computer-aided log rotation is estimated to give a 15% greater yield than conventional log processing methods, and eliminates the chance of operator error when the log is positioned manually. From there, the boards are dried in large kilns to remove the wood's natural moisture, and shipped off to various manufacturing plants.

Optical Scanning

When a board reaches an ALPS manufacturing plant, it will still contain visible surface defects. These defects include knots, decay, worm holes, discolorations, splits and so on. Before a board can be cut into usable parts these defects must be removed. Conventional methods for removing these defects involve a human operator devising an optimal cutting strategy, and then ripping (cutting lengthwise) and crosscutting (cutting across) these defects from the board. The result is a lot of small boards that are suitable to be made into parts. This method can be extremely inefficient due to operator error.

Rather than follow this tradition, ALPS makes use of the latest advances in image processing. In ALPS, a board is scanned with a sophisticated optical scanner. This scanner reduces the board to a black and white digital image containing 256 levels of gray. A computer then takes over and organizes the digital image into a rectangular two-dimensional numerical array. This array is analyzed. Each cell of the array is labeled as clear or defective, depending on whether or not the cell contains one of the many abnormalities that are found in wood.

One great advantage the ALPS scanning process holds over other sorts of scanning processes is the computer's ability to decide whether the cell is defective, as well as what type of defect (e.g., knot or hole) the cell contains. This is possible because most defects can be recognized by the shade of gray that characterizes them. For instance, knots are usually much darker than clear wood, while decay is usually much lighter. Shape also plays an important part in determining the type of defect a cell contains. Defect classification information is of great value to the program being developed by AP, the next operation in the ALPS process.



Sample board (A) showing computer map (B) and the best sawing solution (C)

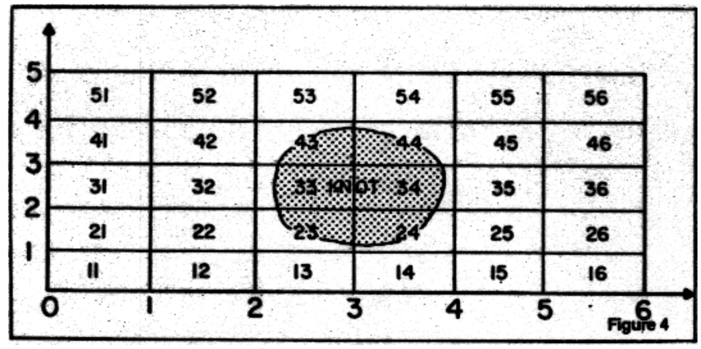
The Optical Cutting Strategy

As mentioned earlier, the program being written by AP outputs an optimal cutting strategy for boards containing defects. The named program is YIELD3 and represents a great advance over previous optimal cutting strategy programs. This is because the YIELD3 output is destined for a laser cutting device, rather than for conventional rip and crosscut saws. It is also revolutionary in that it uses the defect classification information passed to it from the optical scanning process.

To calculate an optimal cutting strategy for a given board, YIELD3 needs the following information:

- a list of all cells of the numerical array in which defects were found,
- a list identifying which type of defect a cell contained,
- a list of parts specified by the manufacturer that need to be cut from the wood, and
- a list from the manufacturer specifying which defects may be contained in various parts of the parts list.

In considering this last item, the defect classification information comes into play. By allowing certain defects to remain in the parts to be cut, a manufacturer greatly increases the number of parts that can be cut from a board and reduces the cost of a given product. The remaining defects are generally ones that will not affect the strength or marketability of the part, or will be hidden from view when the entire product is assembled. By using the information described above, YIELD3 can compute how a given board should be cut so as to produce a maximum number of parts. This computation is output in the form of a series of coordinates, specifying exactly where the parts are to be cut from the board.



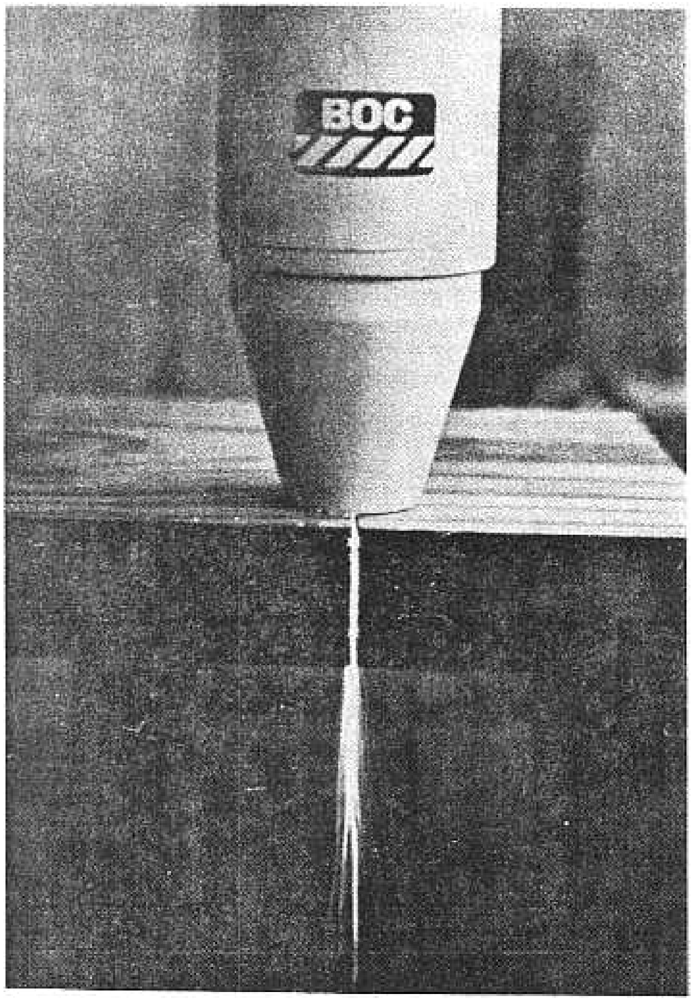
Coordinate system used to establish clear and defective areas on board surface.

Laser Saws

Next comes perhaps the most radical departure from conventional lumber processing methods, that of cutting wood with a laser beam. Conventional methods (ripping and crosscutting) leave a number of smaller 'clean' boards from which manufacturer specified parts are to be cut. When a crosscut is made to remove a defect, it reduces potentially long valuable boards (from which larger parts could be cut) to relatively smaller, less valuable ones.

In contrast, laser cutting offers a number of advantages over mechanical saw cutting. A laser (Light Amplification by Stimulated Emission of Radiation) emits a large number of highly collimated (parallel) rays of light. These rays can be focused through a lens, and at the focal point the intensity of these rays is sufficient to vaporize most substances. The greatest advantage laser cutting offers to the ALPS is its ability to 'blind-cut', that is it can start and stop a cut anywhere on the board. This effect is achieved by employing a high-speed shutter to interrupt the beam when desired. Blind cutting allows the laser to cut profiled (curved) parts, eliminating tedious band sawing and ruining of potentially long boards through crosscutting. Other advantages of using a laser to cut wood include reduced noise, no sawdust, low energy consumption, greater operator safety and a smaller kerf (the term used to denote the width of the cut). A laser's kerf is about .015-inches wide as opposed to a rip-saw kerf of about .25-inches wide.

The biggest disadvantage of using a laser cutting system is the laser's cutting depth. As a laser vaporizes material, it produces a cloud of smoke that can prevent the laser from

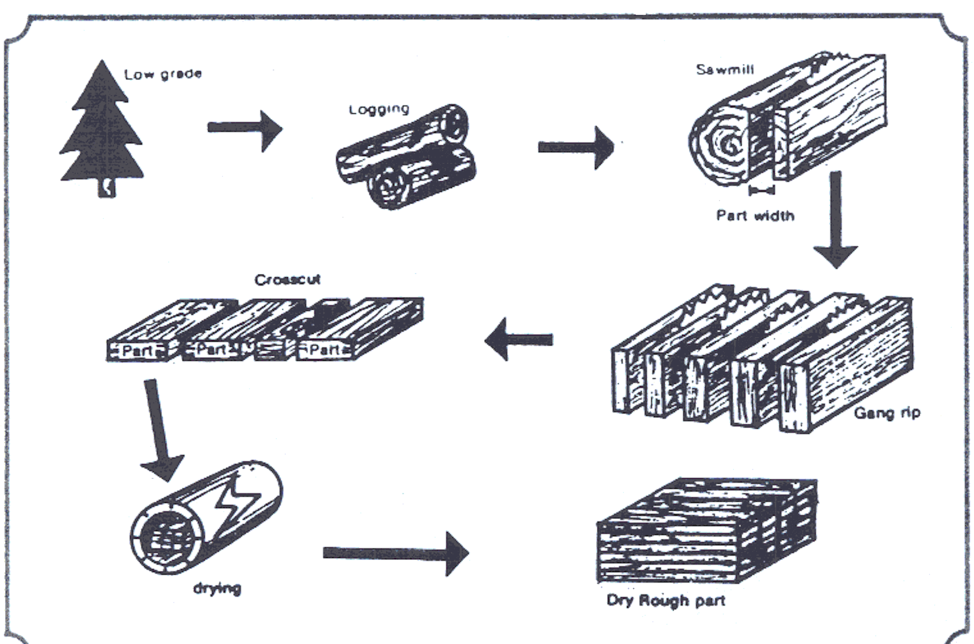


Photograph of continuous carbon dioxide laser cutting a 1-inch thick board in a direction across the grain

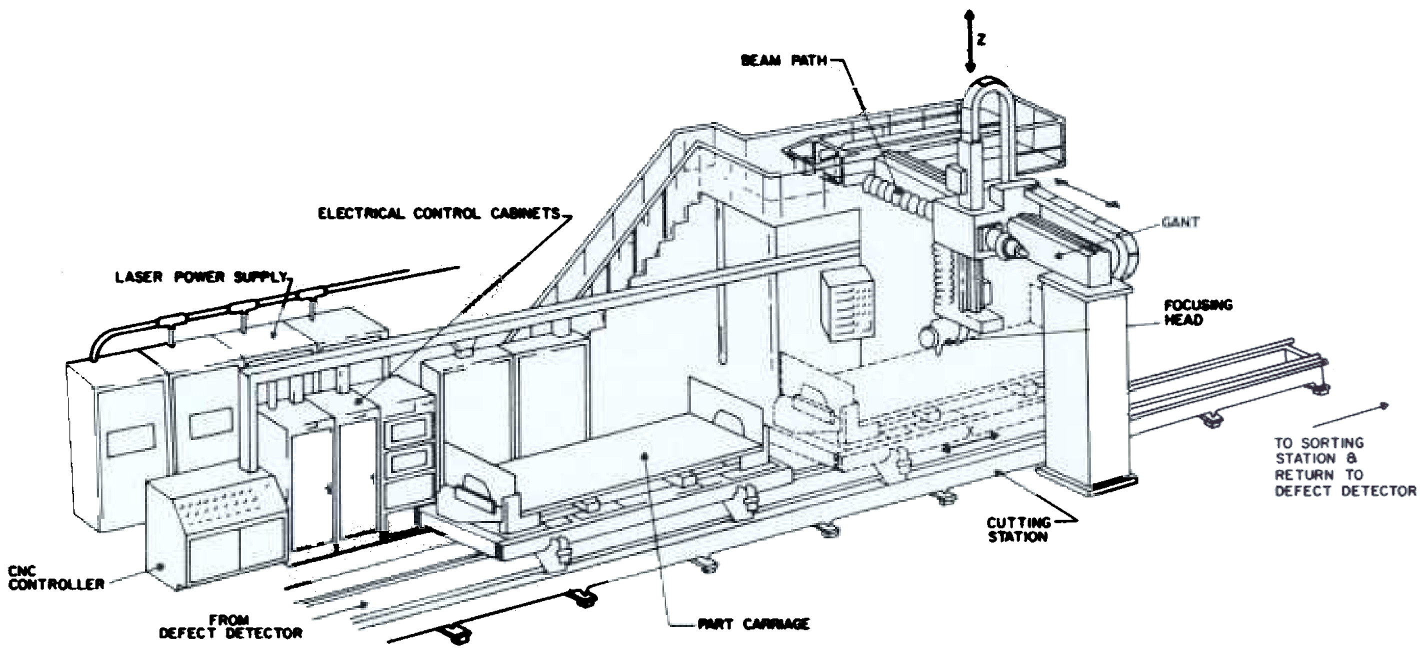
cutting deeper. The deeper the laser cuts, the larger this cloud of smoke grows, further preventing the laser from making contact with the substance. This problem is further compounded when a laser cuts wood. Boards still contain some natural moisture after being kiln-dried. When this moisture comes in contact with the laser beam, steam is produced, adding to the smoke cloud problem. Current technology allows a laser to cut wood to a depth of about one inch before the smoke becomes too thick for the laser to pass through. Lasers also cut much slower than mechanical saws, thus slowing production. However, the disadvantages are overshadowed by a laser's ability to blind cut and its easy adaptability to computer control. This last advantage is especially important to AP's program. Its output, a series of coordinate points, is ideal input for a program that would actually control the laser.

Integrating ALPS

Putting the entire manufacturing process together involves a series of carriages proceeding along a track, with a board tightly secured to the top of each carriage. A carriage first passes through the optical scanning station to be scanned for defects. Information on the location and type of each defect is given to the YIELD3 program, and an optimal cutting strategy is calculated for the board. The carriage proceeds to the laser cutting station. A computer at this station uses the coordinates from the YIELD3 program to manipulate the carriage and laser head. The carriage is oscillated back and forth along the track to produce ripcuts, whereas the laser head is moved from side to side along a gantry spanning the track to produce crosscuts. After the parts are cut from the board, the carriage proceeds to the last station of the ALPS manufacturing process, where the parts are automatically sorted into separate bins.



Material flow from tree to dry rough part shows how the process eliminates the time-consuming lumber-making process.



Conceptual drawing of the ALPS laser cutting system

To date, there are no ALPS manufacturing plants in operation. This is due to the fact that further research is needed on many technical issues before such plants become economically and technically feasible. With this in mind, Michigan State University's Department of Forestry has proposed to build a laser wood cutting laboratory to conduct research on some of these problems. Such a laboratory would be funded by both industry and government, and would provide a unique place to study the implementation and operation of such an advanced manufacturing system. This laboratory would also greatly facilitate the efforts of the AP staff, affording them a practical environment in which to test YIELD3.

TJ Chandler, Technical Communications

Software Notes

Software Modification Proposals

Software Modification Proposals (SMPs) are documents written to initiate modifications of the MSU software system. An SMP is written by a member of the Computer Laboratory staff, then circulated among other staff members for additional comments and viewpoints. SMPs are also filed in the User Information Center (UIC), Room 114 Computer Center, for users who wish to review them.

There are two types of SMPs: 1) those which directly affect users, and 2) those which describe internal changes having no direct effect on users. This article describes SMPs of the first type written since publication of the Spring issue of *Acronyms*. SMPs with the prefix 'SYS' were written by the Systems Development staff; those with the prefix 'UIC' were written by the User Information Center staff.

There is a HELP file which contains a listing of current SMPs with a brief synopsis of each. The file is updated as SMPs